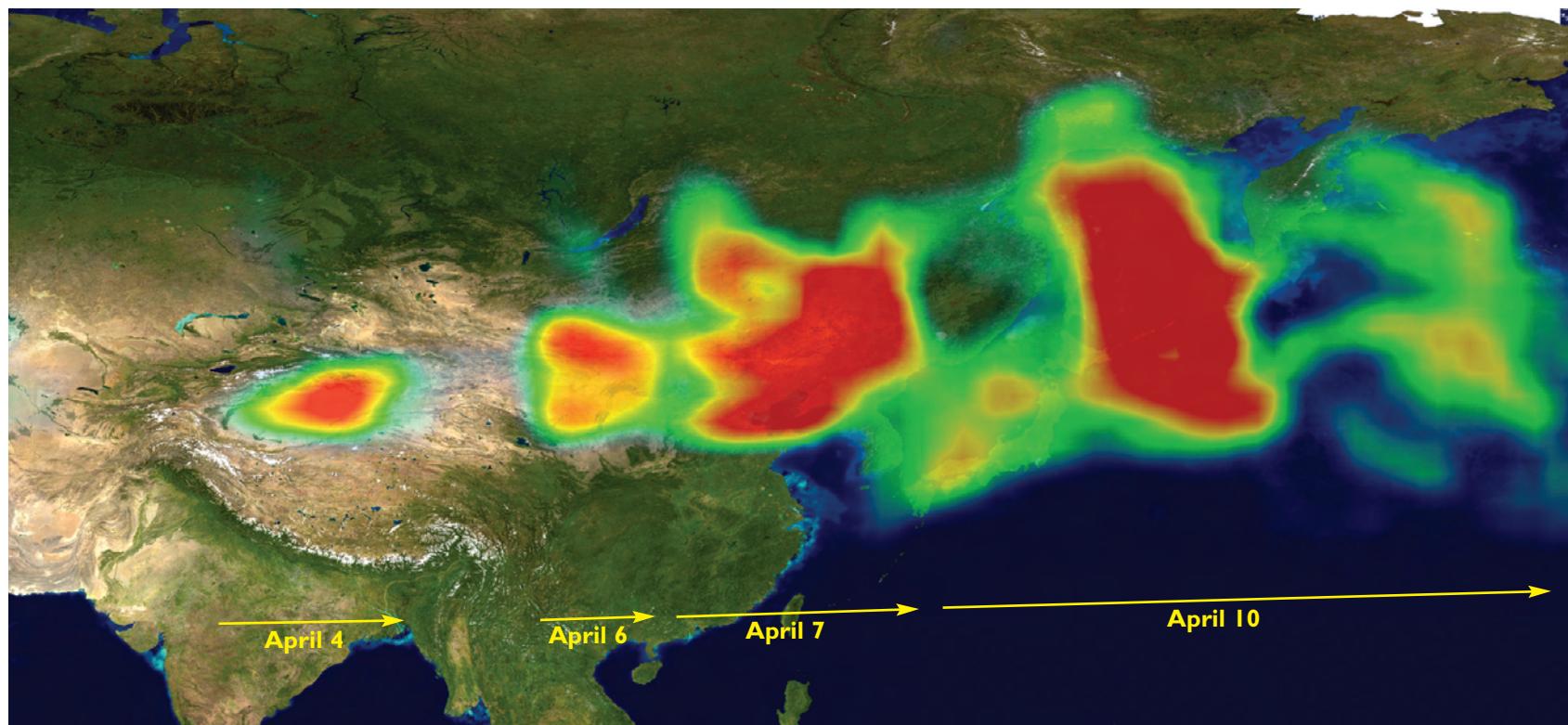


Dust in the Wind

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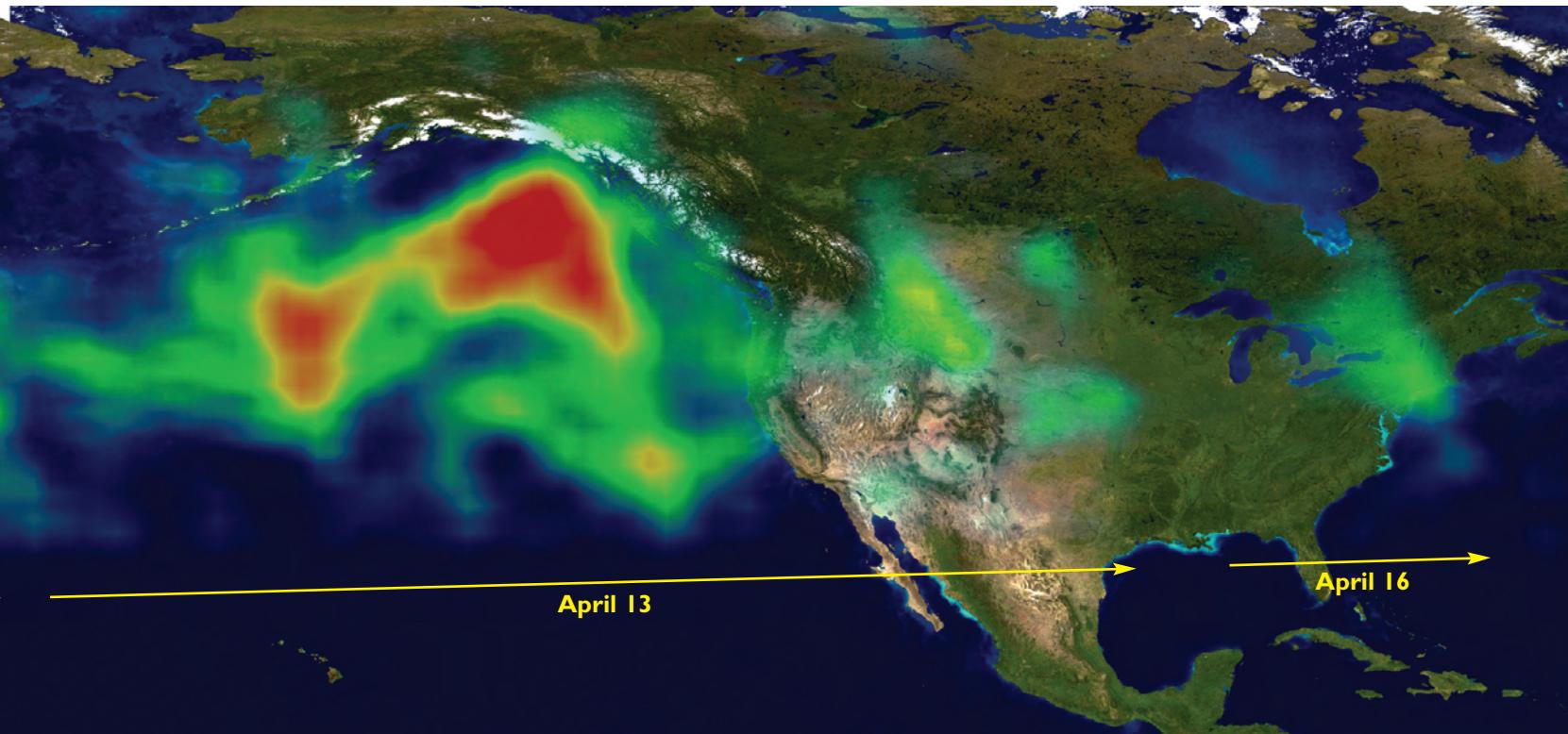


A composite of aerosol index measurements taken from April 4–16, 2001 dramatically illustrates the transport of dust from a huge storm in China that moves across the Pacific Ocean and North America to the Atlantic Ocean. The arrows indicate the size and location of the dust cloud observed on the date given below. Red areas indicate high aerosol index values and correspond to the densest part of the dust cloud. Yellows and greens are moderately high values. (Data from the TOMS instrument on the Earth Probe satellite.)

When strong winds blow through arid regions, immense amounts of dust often get lifted from the surface and injected into the atmosphere. These dust storms, like many other types of natural hazards, often impact human activities in dramatic ways when passing over inhabited areas, causing breathing problems, delaying flights, pushing grit through windows and doors, forcing people to stay indoors, and generally creating havoc.

The ability to monitor and study dust storms increased significantly in the 1970s when satellite instruments started to provide unprecedented views on their size, scale, and movement. The unique vantage point provided by satellites helped lead to discoveries of how these storms affect the environment, and us, in less obvious but even more important ways. For example, the ability to detect and track the movement of dust from satellites indicated a link between the outbreak of meningitis in the Sahel and active dust storm periods in the Sahara. Also, by showing that mineral dust provides a source of iron to fertilize phytoplankton growth by being routinely transported from the Saharan desert into the Atlantic Ocean, this capability illustrated the vital biogeochemical role dust storms play in the ecosystem. This same dust-laden air also supplies crucial nutrients for the soil of rain forests in South America.

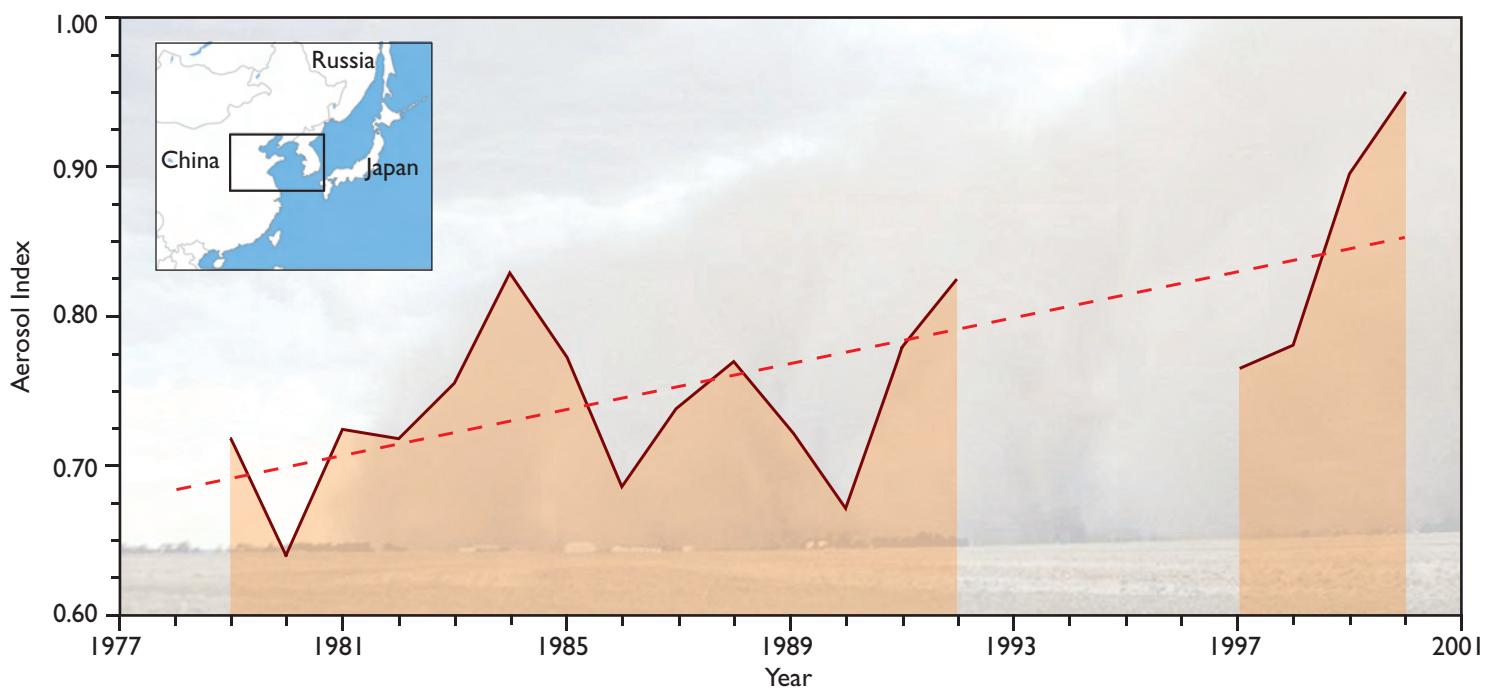
Satellite measurements of dust characteristics also provided much needed information used to determine how dust particles affect the climate by redistributing solar energy within the Earth's atmosphere and by changing the thermal contrast between land and ocean. When



interacting with sunlight, these tiny particles not only absorb solar radiation, but also reflect it back to space. The result is a net warming effect in the dust-laden atmosphere and a net cooling effect on the Earth's surface. Exactly how different types of dust modify Earth's radiation budget depends on how the absorption of sunlight by particular types of dust changes with wavelength, in other words the dust's color. Asian dust is yellowish, Saharan dust is



Street scenes over the air base in Al Asad located near the western desert of Iraq during the passage of a dust storm on April 26, 2005. The passage of such storms can change both the atmospheric visibility and the actual color of the sky in a matter of minutes. (Photograph courtesy of Gunnery Sgt. Shannon Arledge.)



Time series of the 1977–2001 springtime (March, April, and May) averaged aerosol index over East Asia (32°N – 40°N , 112°E – 130°E). (Data from the TOMS instruments on the Nimbus 7 and Earth Probe satellites.)

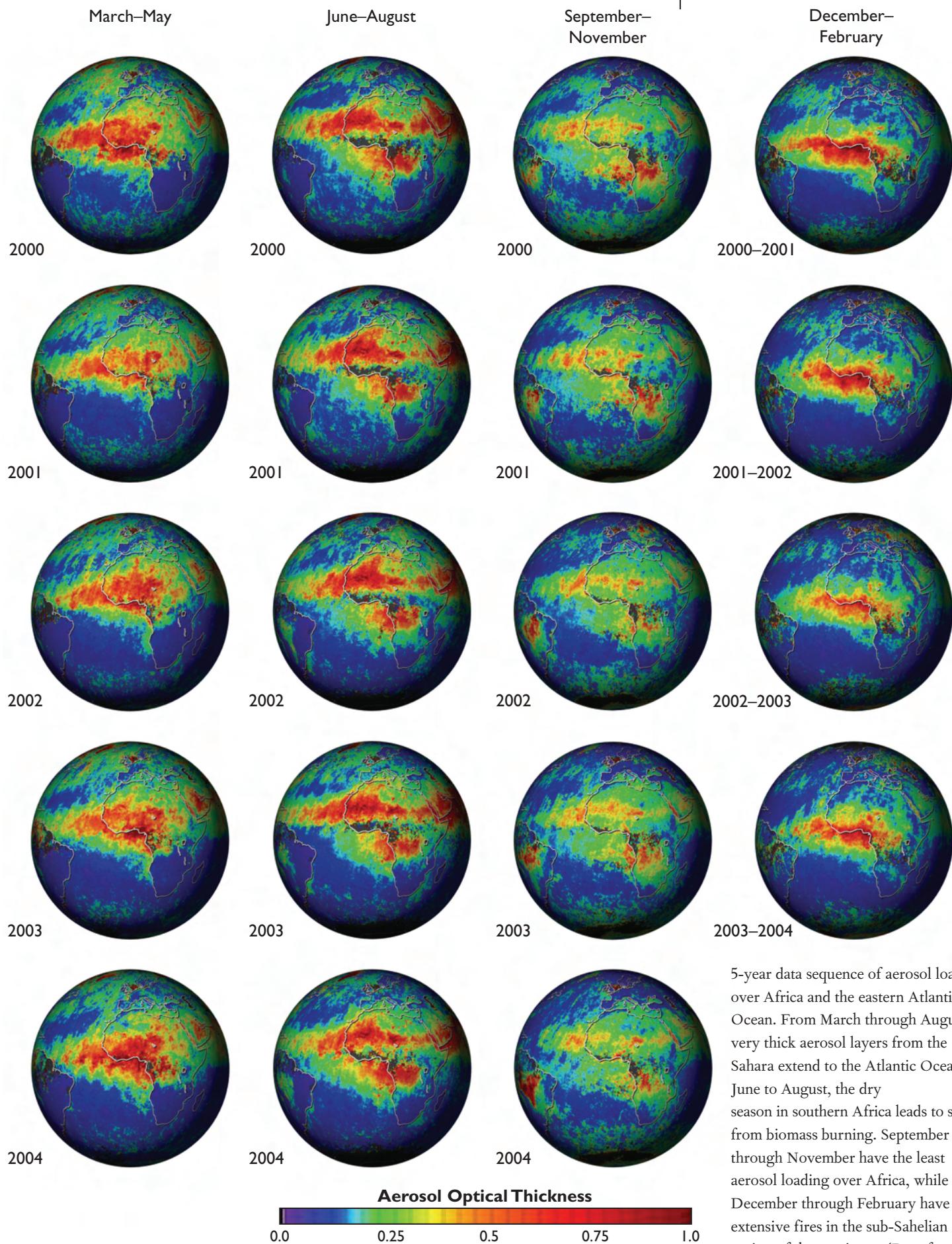
generally more brownish, while some dust, such as that found in the Bodele Depression in Chad, even looks white.

One of the more dramatic results provided by satellite measurements was the discovery that fine airborne dust particles can travel remarkably long distances, impacting all of the environments along their transport pathway. In the spring, dust from storms occurring over Asia are caught by the prevailing winds of the jet stream and observed to travel from China across the Pacific to the west coast of North America, sometimes even crossing the United States and Canada to reach the Atlantic Ocean. These dust clouds have a significant impact on the springtime air quality over North America.

Although dust storms are natural events, surface disturbances associated with human activities may also contribute to the trend in the amount of mineral dust transported in the atmosphere. During the last 3 decades, the ability to monitor the size and distribution of dust storms from space has been critical in shedding light on how man has affected the development and magnitude of these storms. Uncontrolled land use such as overplowing, overgrazing, and overdevelopment, coupled with periods of drought, often leads to a massive deterioration of land cover, intensifying the frequency of occurrence of large-scale dust storms. In one example, satellite observations suggest an increase in both the intensity and frequency of dust storms over East Asia that parallels the manmade development, and consequent change in the qualities of the land surface, occurring in northwestern China during the same time period.

Since the beginning of the new millennium, measurements from instruments on NASA's Earth Observing System (EOS), and new techniques developed to analyze them, have added many capabilities needed to help improve the mapping and prediction of dust storms. Information obtained from the MODIS and MISR sensors now allow scientists to study the optical and microphysical properties of mineral dust from sources to sinks on a much finer scale than previously available from satellite.

In particular, measurements made by different instruments passing overhead at different times have been instrumental in studying the creation and evolution of dust plumes over



5-year data sequence of aerosol loading over Africa and the eastern Atlantic Ocean. From March through August, very thick aerosol layers from the Sahara extend to the Atlantic Ocean. In June to August, the dry season in southern Africa leads to smoke from biomass burning. September through November have the least aerosol loading over Africa, while December through February have extensive fires in the sub-Saharan region of the continent. (Data from the MISR instrument on the Terra satellite.)

time. A comprehensive understanding of the properties of these tiny particles as well as their temporal and spatial distribution is imperative to understanding how the Earth's atmosphere maintains its current state of equilibrium and how anthropogenic activities could potentially destroy that balance.

Dust storms frequently occur over places like northern Africa and southwest Asia all year round. Extensive dust clouds were observed from space over Iraq, Syria, and Kuwait, as well as over the Persian Gulf on August 7, 2005 (top panel). The corresponding intensity of the dust plume is also depicted using a unitless quantity called 'optical thickness' (bottom panel). The higher the dust optical thickness, the more dust is in the atmosphere. (Data from the MODIS instrument on the Aqua satellite.)

